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Digital Radiography and X-ray Computed Tomography Slice Inspection of an Aluminum Truss Section

by William H. Green

ARL-MR-791

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A sectioned specimen that had been removed from a larger aluminum truss structure, which was designed to sustain mechanical load while minimizing its weight and structural complexity, was provided. The specimen was inspected by digital radiography and slice x-ray computed tomography to determine if the vertices, or nodes, exhibited any porosity or shrinkage cavities and, secondly, if any other casting defects were present.					
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1. Introduction

A sectioned specimen that had been removed from a larger aluminum (Al) truss structure was provided. The specimen was inspected by digital radiography (DR) and slice x-ray computed tomography (XCT) to determine if the vertices, or nodes, exhibited any porosity or shrinkage cavities and, secondly, if any other casting defects were present.

2. Description of Specimen

The specimen had a two-tier structure with eight ligaments at each vertex, four that are horizontal and four that are diagonal, as shown in figure 1. The overall size of the specimen was ~69 mm (2.7 in) \times 187 mm (7.4 in), with spacing between the tiers (outside surface to outside surface) of ~37 mm (1.5 in). The specimen material was cast F357 Al alloy.

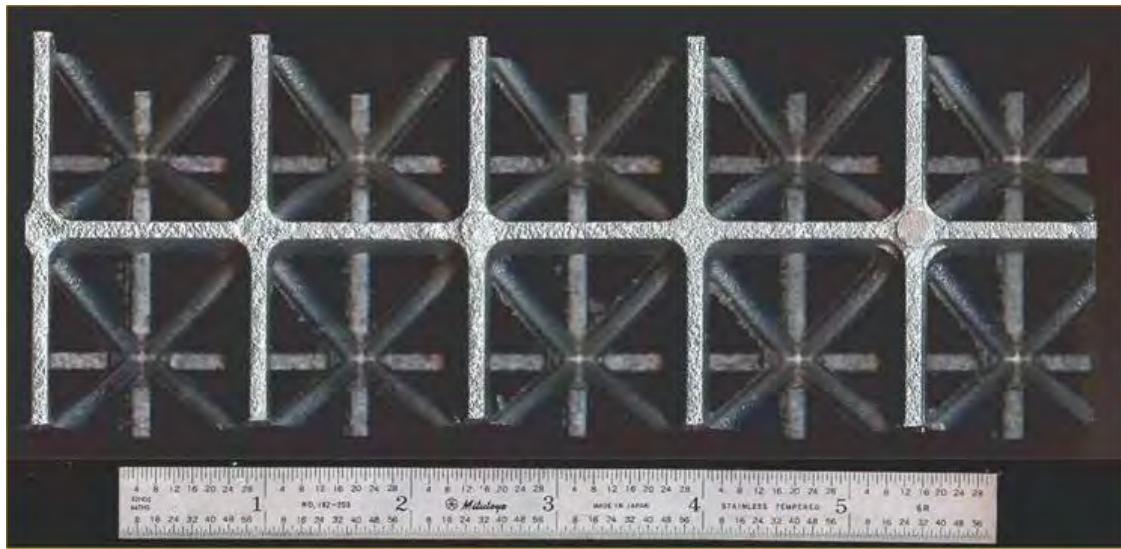


Figure 1. Photograph of cast Al truss section specimen.

3. Results

The DR and XCT scans of the specimen were done using the 225-keV microfocus x-ray tube and II/CCD camera setup in centered rotate-only mode. The DR scan parameters are listed as follows:

- Source Voltage 180 kV (microfocus source)
- Source Current 0.044 mA
- Focal Spot Size 5 μm
- SID 641.50 mm
- SOD 325.00 mm
- Mag Factor ~ 2.0 (1.97)
- Image Matrix 1966×1024
- Image Width (x) 90.21 mm
- Detector Image intensifier and CCD camera (total 14 bit, true 12 bit)

The XCT scan parameters are listed as follows:

- Source Voltage 180 kV (microfocus source)
- Source Current 0.044 mA
- Focal Spot Size 5 μm
- SID 641.50 mm
- SOD 325.00 mm
- Mag Factor ~ 2.0 (1.97)
- Image Matrix 1024×1024
- FOR 90.00 mm
- Image Size 90.00×90.00 mm (x by y)
- Scan (Slice) Location Third horizontal row of two vertices/nodes from the bottom of DR (cross-sectional image)
- Slice Thickness 0.60 mm
- Detector Image intensifier and CCD camera (total 14 bit, true 12 bit)

Note: SID = source-to-image-distance; SOD = source-to-object-distance; CCD = charged coupled device; and FOR = field of reconstruction.

The DR and single XCT scans of the specimen are shown in figures 2 and 3, respectively. The specimen was positioned vertically, standing on end in the DR to maximize the magnification factor. The through-thickness DR did not indicate the presence of any porosity or shrinkage cavities in the vertices of the specimen. The DR also did not indicate the presence of cracks or other internal casting defects in the specimen. The lack of these types of defects was further exhibited by the representative x-ray CT scan (slice) taken through one of the horizontal rows, relative to the DR, of two particular vertices. The CT scan was taken through the third row of two vertices from the bottom of the DR. The vertices are at the bottom of the image in figure 3, which also shows the rest of the material penetrated by the cross-sectional scan. The material at the top of the image is located at the other tier of the two-tier truss structure. The darker shade of gray between the two vertices is not an indication of lower density in this case but is due to geometry effects of relatively long x-ray path lengths through the horizontal material section at the bottom of the image.

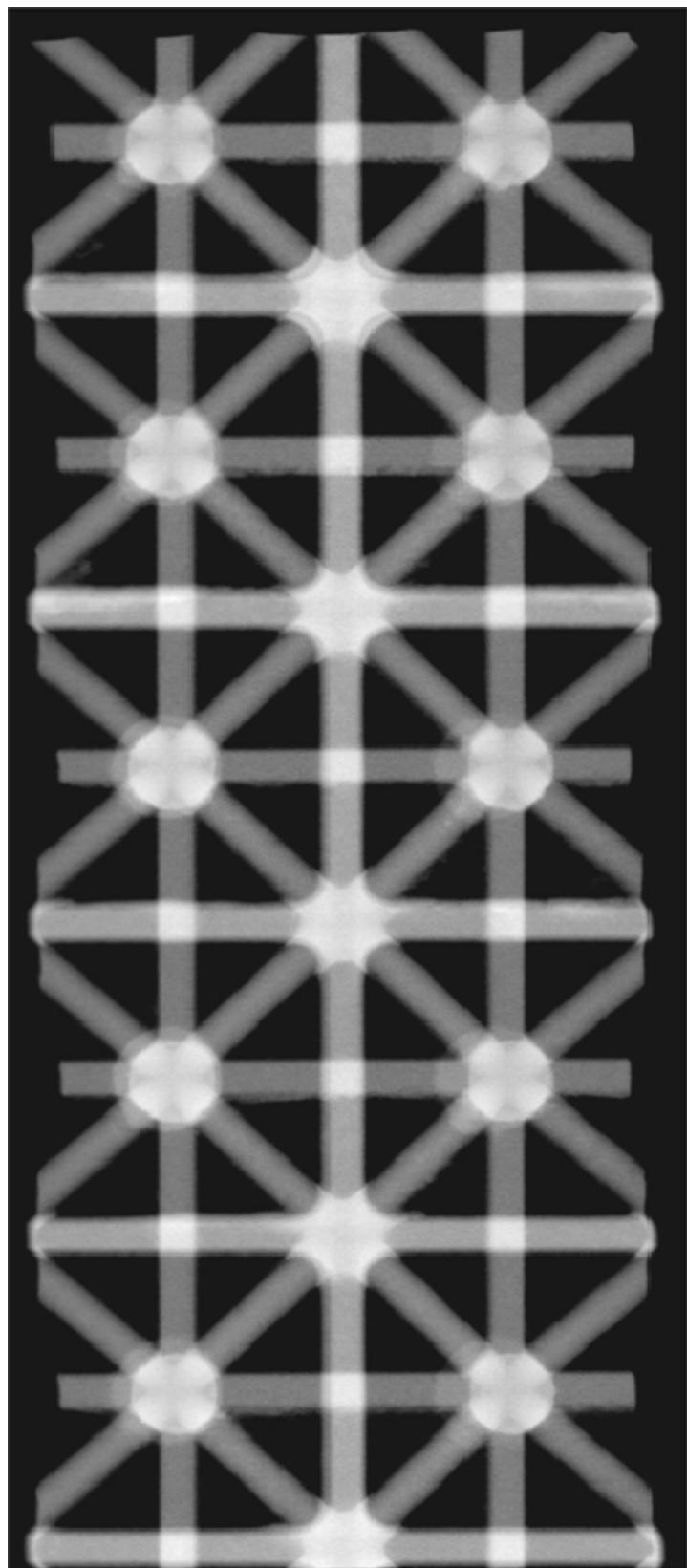


Figure 2. Digital radiograph of Al truss section specimen.

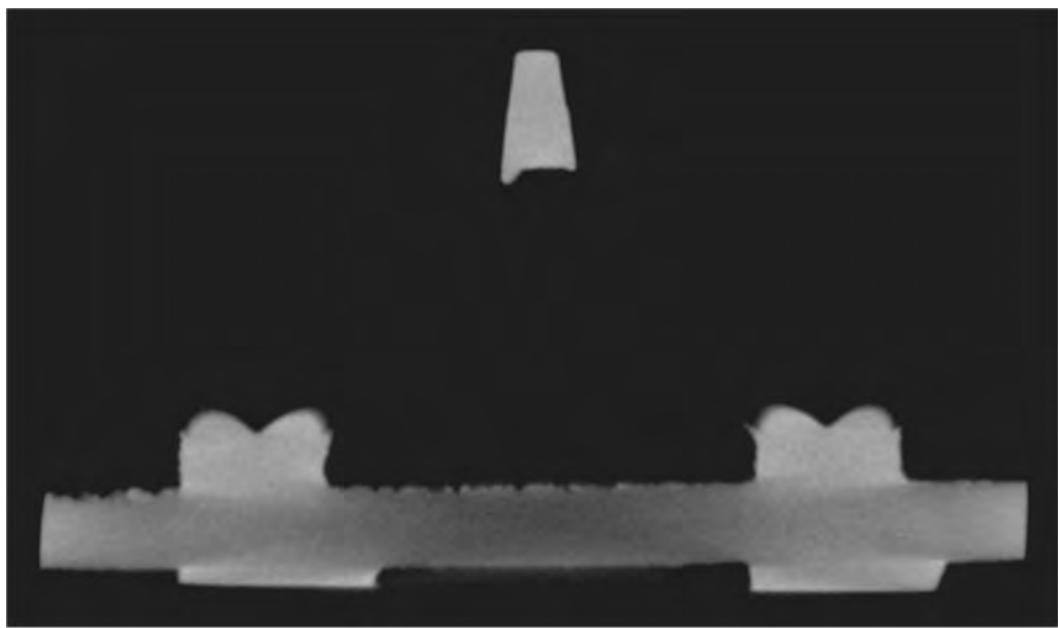


Figure 3. Computed tomography scan through two selected vertices (bottom) of Al truss section specimen.

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